

The change of global spectral reflectance as EPIC observed sunlight approaching perfect backscattering

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Effect of scattering angle on DSCOVR/EPIC observations

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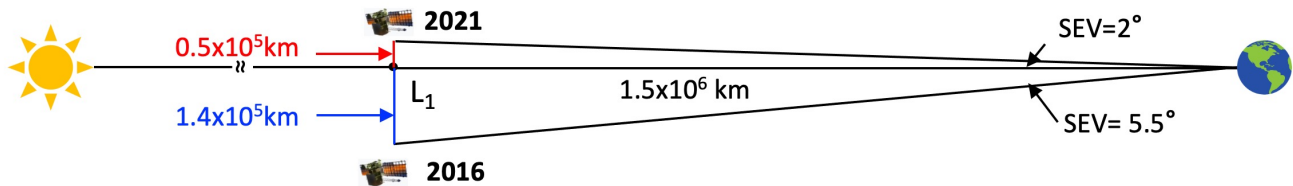
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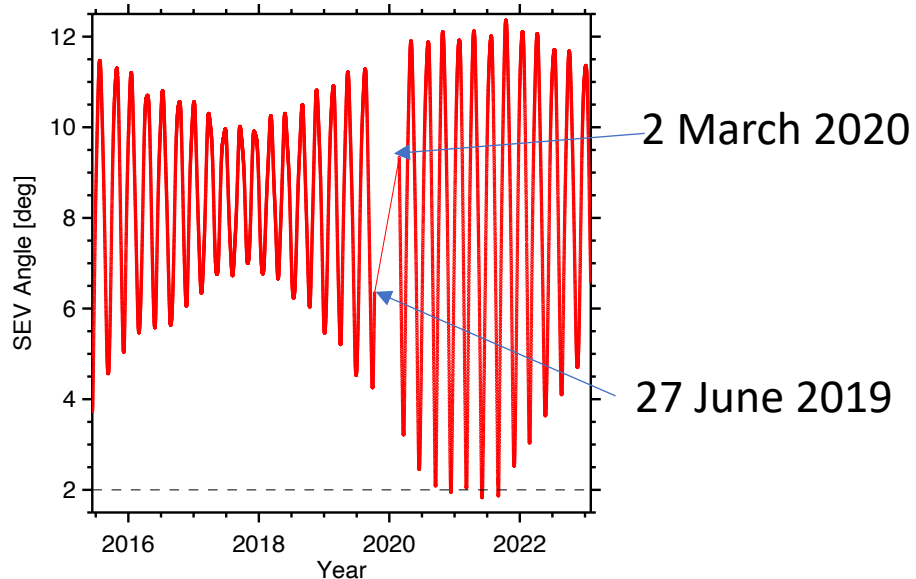
DSCOVR EPIC and NISTAR STM

Change of SEV angle after DSCOVR came back from safe hold due to degradation of an inertial navigation unit

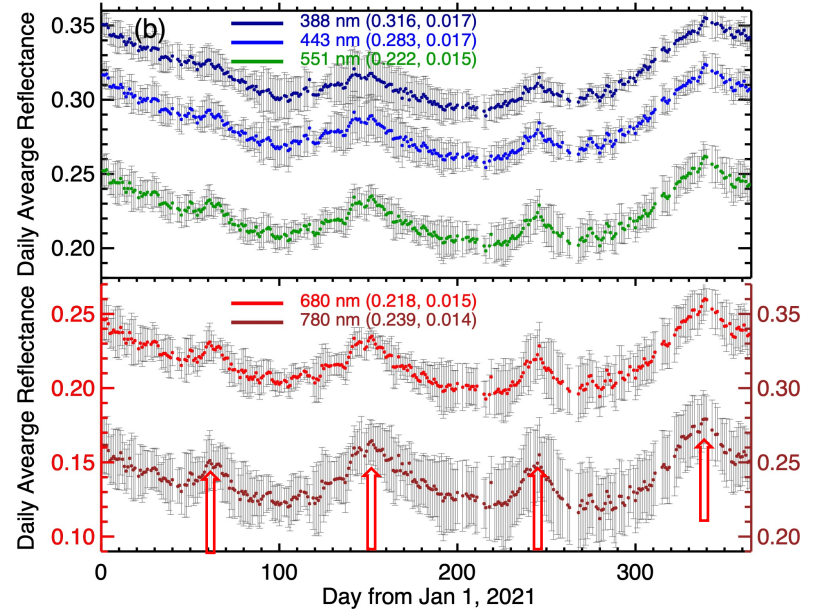
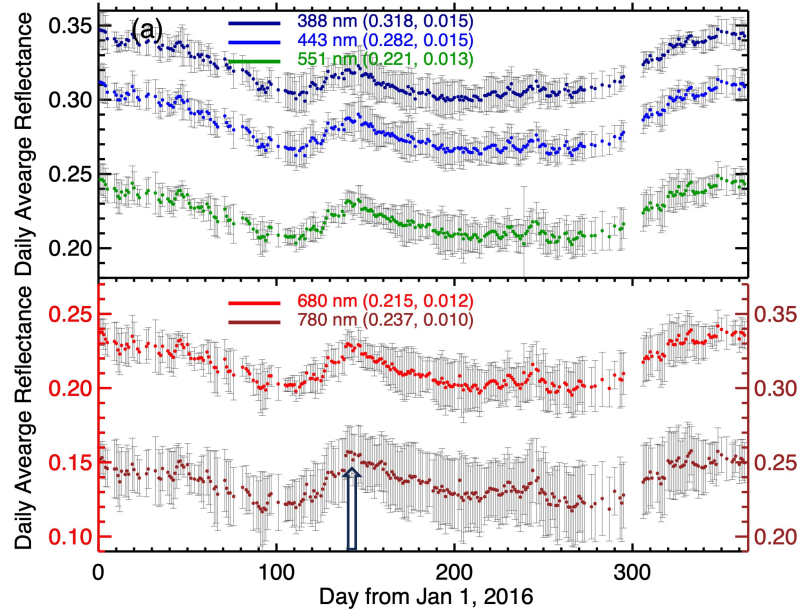


- Min SEV is $\sim 5.5^\circ$ in 2016
- Min SEV is $\sim 2^\circ$ in 2021

$$\text{SEV Angle} = 180^\circ - \text{Scatt. Angle}$$



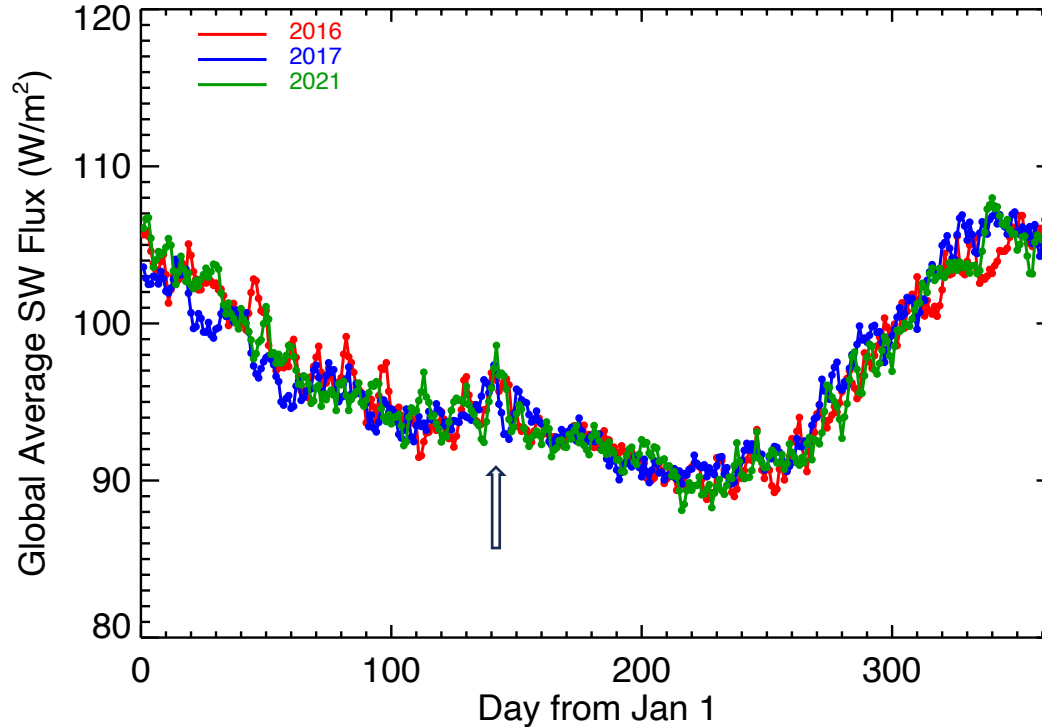
What Happened to Global Spectral Reflectance?



- There are four spikes in reflectance in 2021 and wavelength dependence
- Only one in 2016

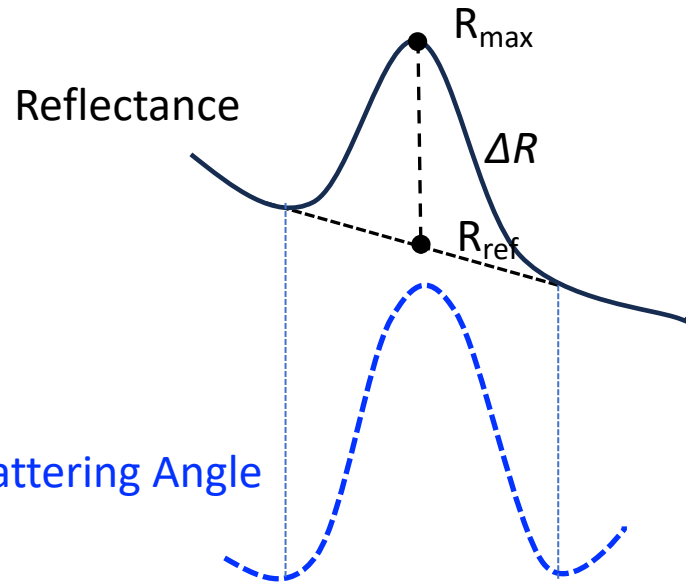
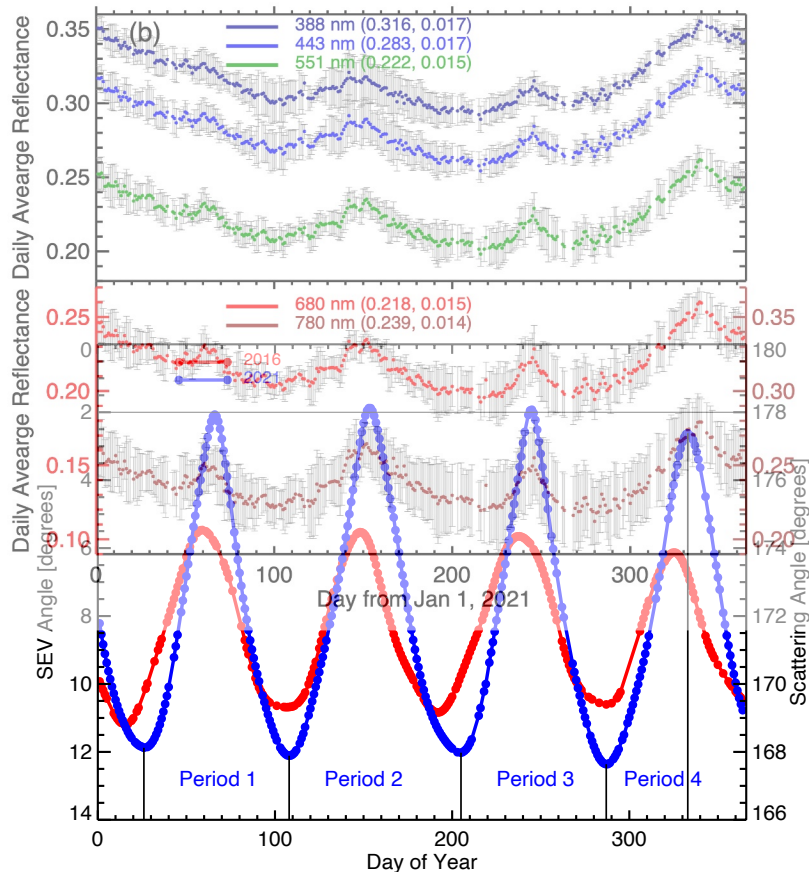
Check CERES TOA SW Fluxes

CERES SW Flux



- Year-to-year variations are small in TOA SW flux
- One spike similar to EPIC reflectance in 2016
- The four spikes in 2021 are unlikely due to changes in Earth's atmosphere

Spikes of Reflectance coincide with peaks of scatt. angle

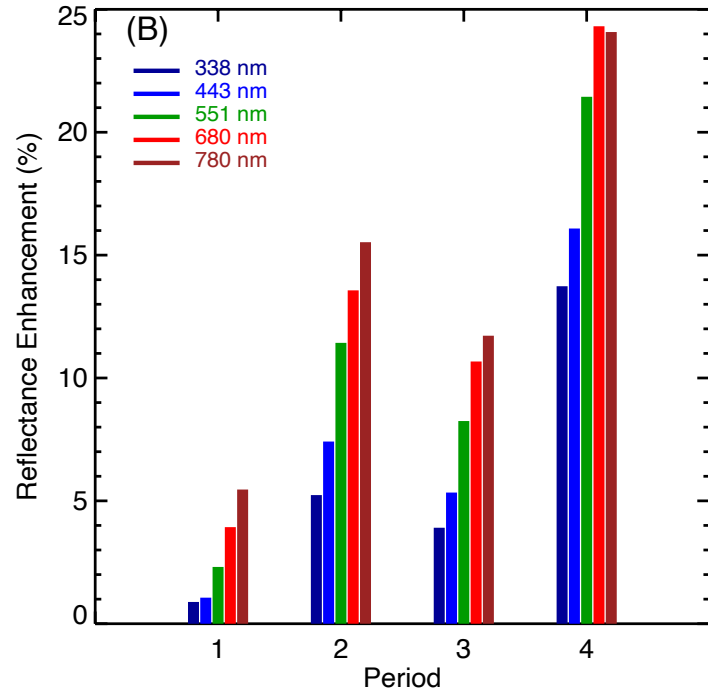
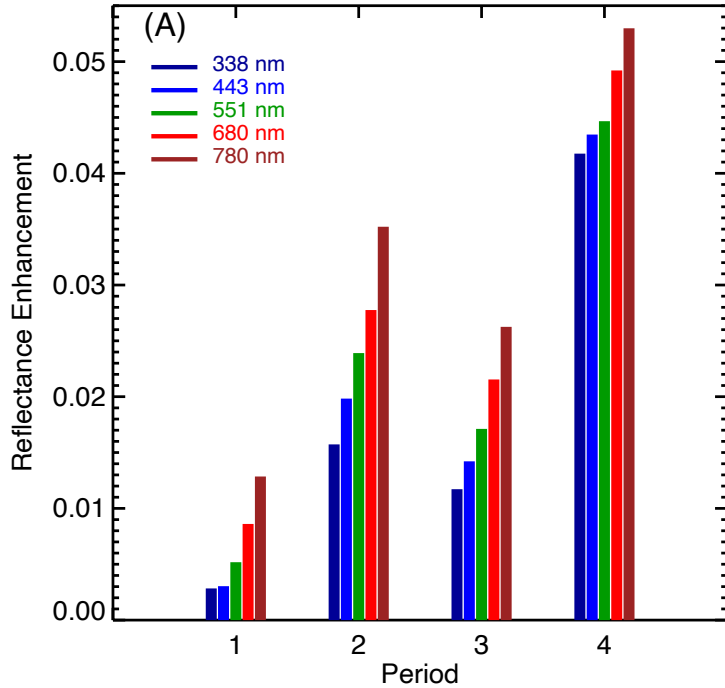


Definition: the change of reflectance in a period of scatt. angle variation is

$$\Delta R = R_{max} - R_{ref}$$

$$\Delta R(\%) = (R_{max} - R_{ref}) / R_{ref}$$

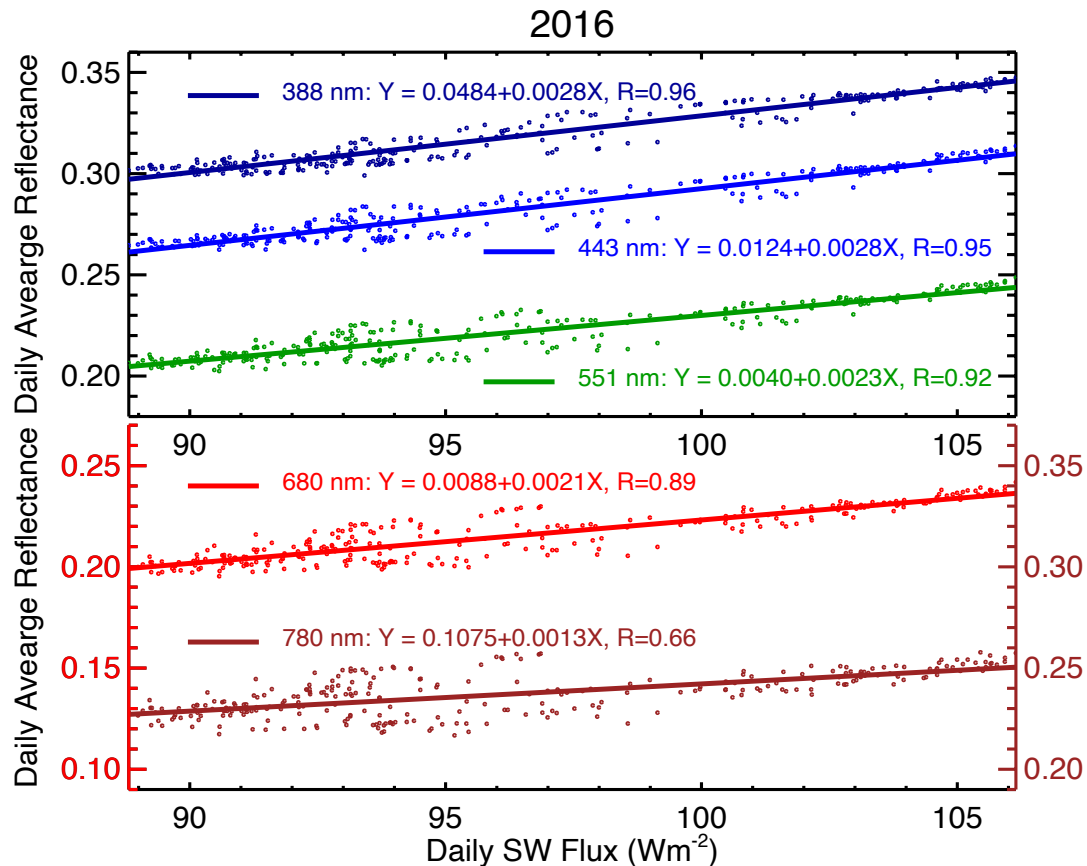
Magnitude of the spikes



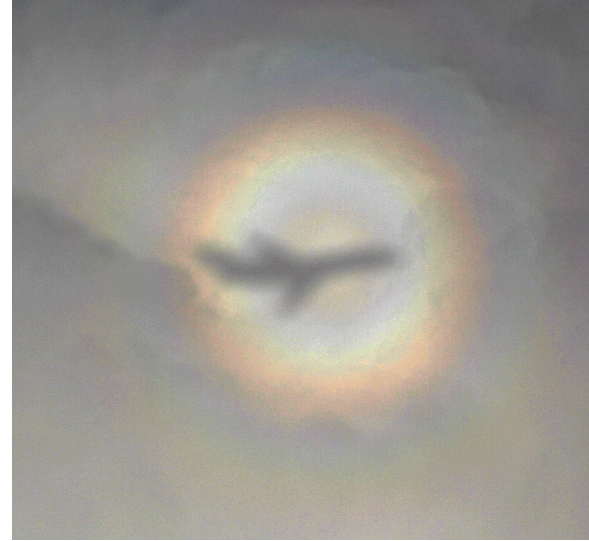
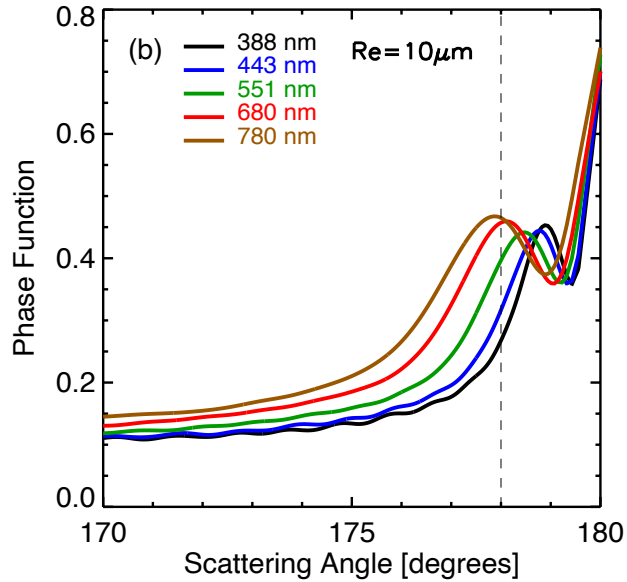
- Enhancement increases with wavelength
- Enhancement varies from one period to another

Reflectance and Cloud Fraction Positively Correlated

- Reflectance is highly correlated with CF
- Correlation coefficient is largest for UV and blue wavelengths
- Correlation coefficient decreases with wavelength

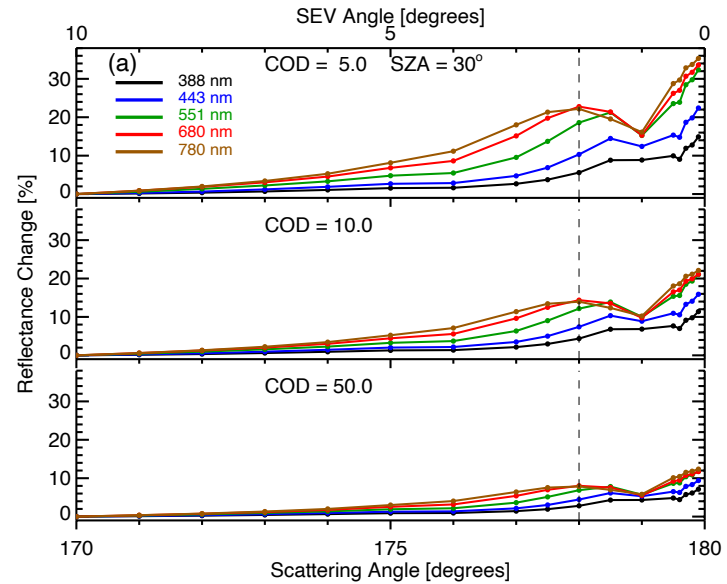
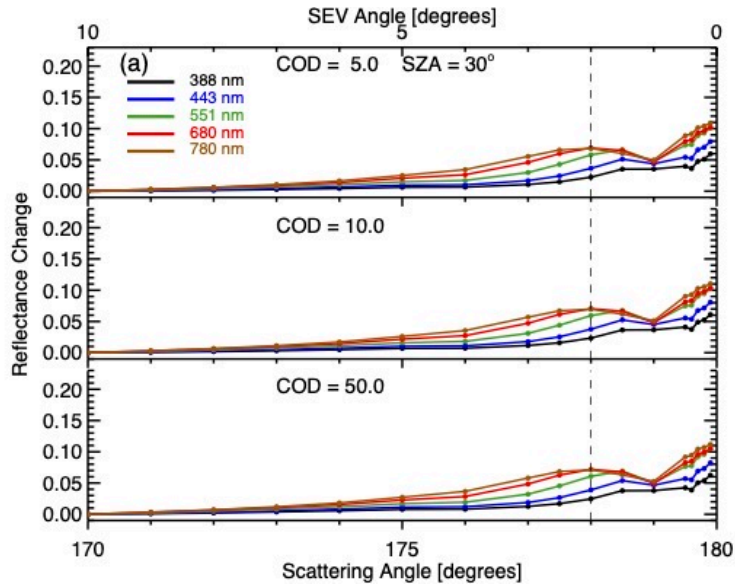


Cloud Scattering Phase Function Strongly Depends on Scatt. Angle



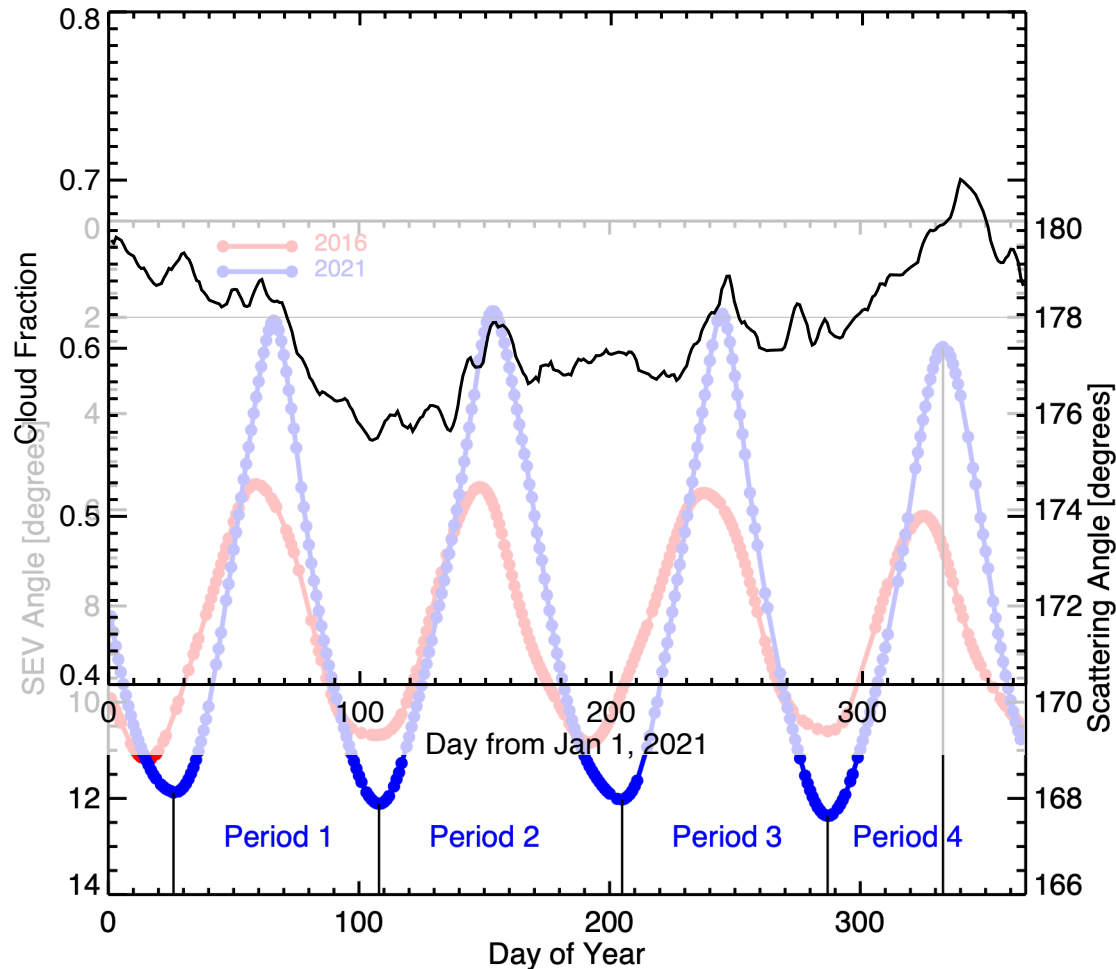
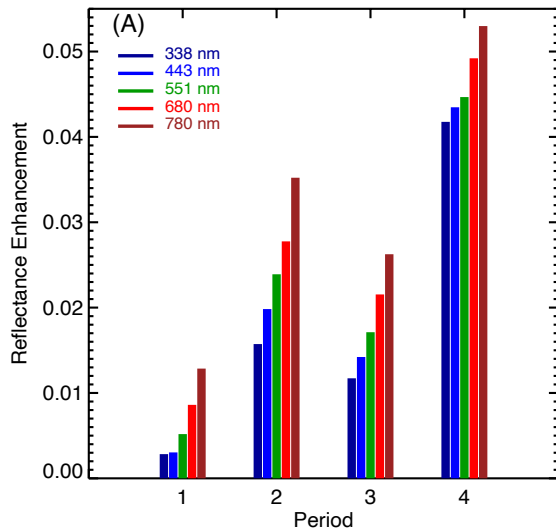
- Phase function depends strongly on wavelength
- So called glory effect

Reflectance Change vs Scatt. Angle and Wavelength



- Reflectance depends strongly on scattering angle and wavelength
- Single scattering dominates
- Percent change depends on COD

Role of CF and Scatt. Angle in Reflectance Change



- Change of CF is in phase with scattering angle $\rightarrow \Delta R \uparrow$
- Change of CF is out of phase with scattering angle $\rightarrow \Delta R \downarrow$

Summary

- Scattering angle approaches near perfect back scattering → larger increase in cloud reflectance and wavelength dependent
- For each period, the change of reflectance is the results of change in CF and scattering angle. In phase vs out of phase.
- Implications → ADM also strongly depends on scattering angle, COD retrieval, ...